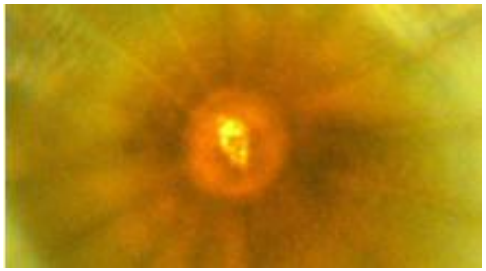
Infrared Light Probes Hydrogen Under Extreme Pressure

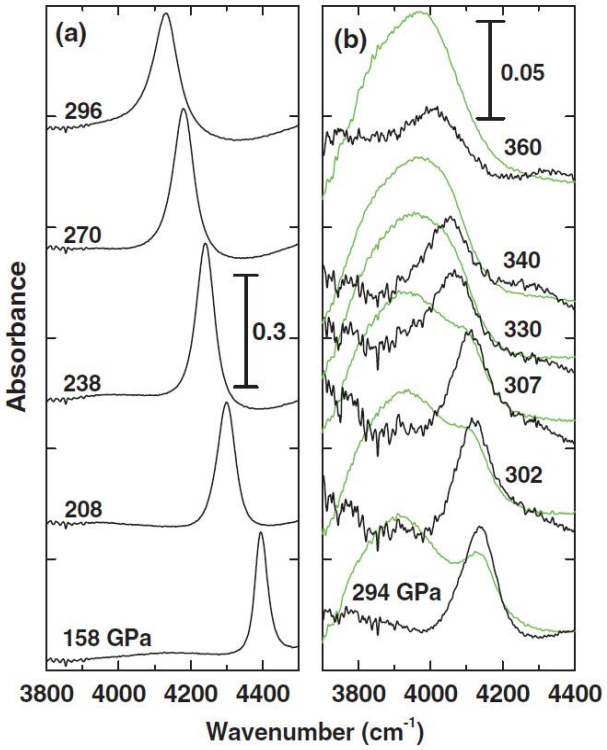
- The two-atom hydrogen molecule is the simplest molecule in existence, but scientists still don't know some basic information about it, such as how it responds to very high pressures.

- At NSLS, researchers studied hydrogen's stability and electronic properties when subjected to high pressures and temperatures of room temperature (294K) and below.



- They applied pressures above 300 gigapascals (GPa), or about three million times atmospheric pressure, using diamond anvil cells, which squeeze a sample between the faces of two diamonds. At beamline U2A they studied the sample with infrared light, focusing on the “vibron,” the stretching vibration between the two atoms, as well as the characteristic infrared signature of the proposed transformation of the material into a mental.

- The persistence of the vibron over the full pressure/temperature range, indicated by strong infrared absorption, showed that the hydrogen molecules remained intact to remarkably high pressures and temperatures up to room temperature. The group found that solid hydrogen does not become a metal under those conditions, an assertion made by another group in a paper last year.



Left: An image of the hydrogen sample (bright yellow center) taken while inside the diamond anvil cell, at a pressure of 360 GPa and room temperature. Right: Infrared absorbance spectra of a hydrogen sample at 80K. The vibron is indicated by the large absorption peaks in the data, which are evident at all pressures.

C. Zha, Z. Liu and R. Hemley, "Synchrotron Infrared Measurements of Dense Hydrogen to 360 GPa ," Phys. Rev. Lett., 108, 146402 (2012).